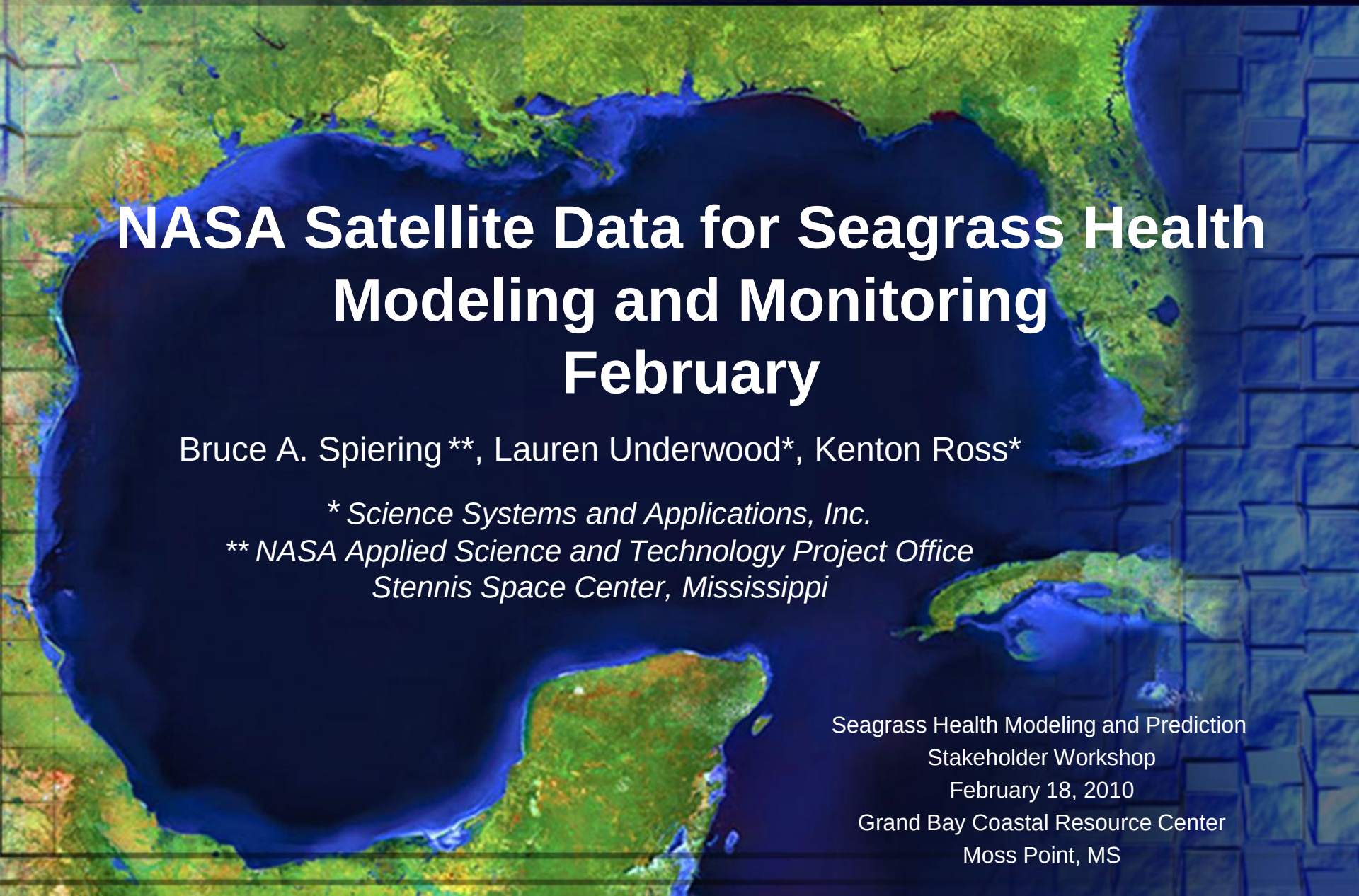
National Aeronautics and Space Administration



NASA Satellite Data for Seagrass Health Modeling and Monitoring February

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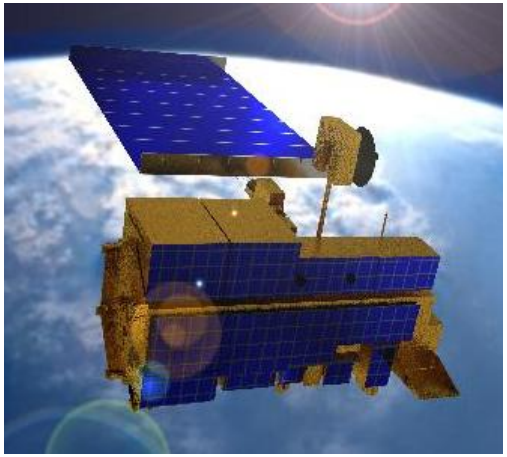
Background

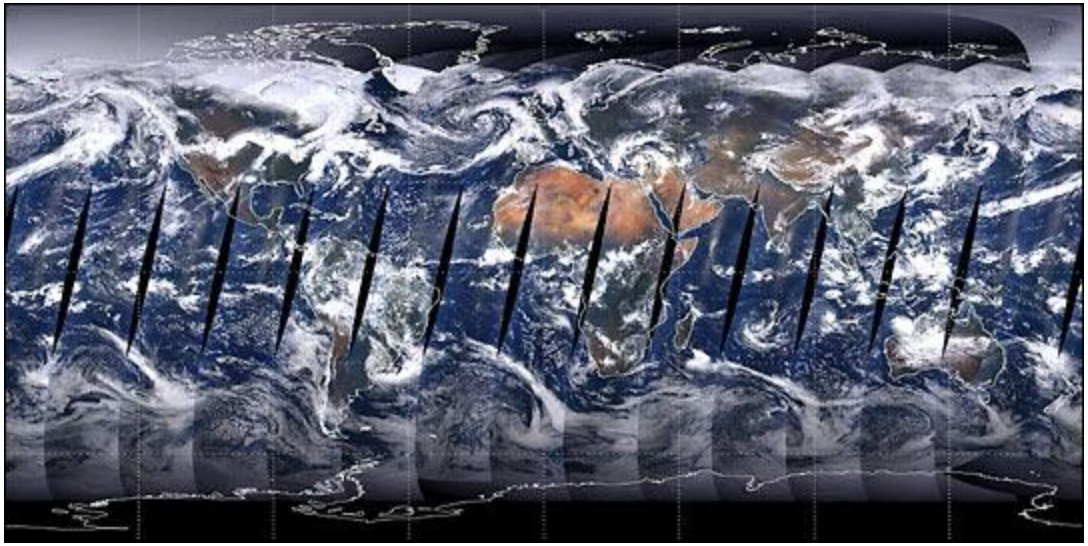
- As noted by Fong and Harwell (1994), their model of seagrass productivity may be enhanced by using remote sensing data
- Long-term, spatially and temporally resolved measurements of chlorophyll *a* concentration, light attenuation coefficient and sea surface temperature can be estimated from the remote sensing data … in particular, the NASA MODIS sensor can be useful in supplying these parameters

Satellite Observations

- MODIS (Moderate Resolution Imaging Spectroradiometer)
  - 2 instruments deployed on different NASA Earth Observing System satellites:
    - Terra, launched in December 1999, 10:30 AM sun-synchronous orbit (descending)
    - Aqua, launched in May 2002, 1:30 PM sun-synchronous orbit (ascending)
  - 36 spectral bands: 20 reflective solar bands with wavelengths from 0.41–2.2 μm and 16 thermal emissive bands with wavelengths from 3.7–14.4 μm
  - 3 spatial resolutions (GSD at nadir):
    - 250 m (2 reflective bands: 600-900 nm)
    - 500 m (5 reflective bands: 450-2,200 nm)
    - 1 km (13 reflective bands: 410-1,400 nm)
  - extensive calibration efforts to continuously maintain data product quality and to enable creation and analysis of multi-year time series of atmospheric, terrestrial, and ocean measurements



MODIS

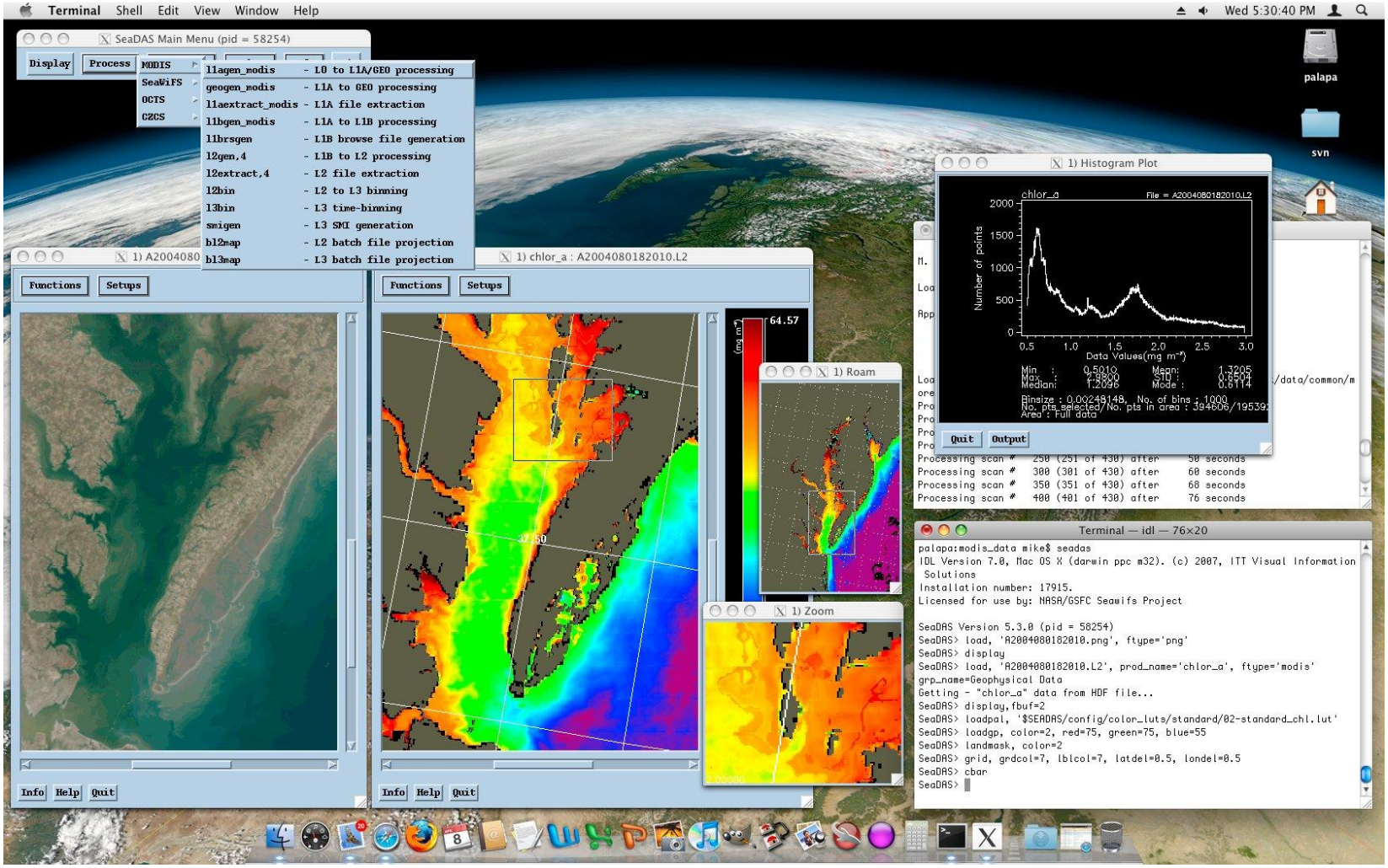


The MODIS instrument is operating on both the Terra and Aqua spacecraft. It has a viewing swath width of 2,330 km and views the entire surface of the Earth every one to two days. Its detectors measure 36 spectral bands and it acquires data at three spatial resolutions: 250-m, 500-m, and 1,000-m.

Remotely sensed parameters provided

- Exploit established SeaDAS processing of MODIS time series data where possible
- Additionally, develop scripts and methods to produce the MODIS-derived products needed for the project
  - Adapt sea surface reflectance and temperature processing for near shore effects, potentially including development of a new land mask to allow for processing of data closer to shore
  - Produce an archive, for the period from 2004 to 2009, of custom data products for daily and multi-day aggregates for input into the Fong & Harwell model
    - Chlorophyll-a concentration
    - Diffuse light attenuation coefficient (water clarity)
    - Sea surface temperature

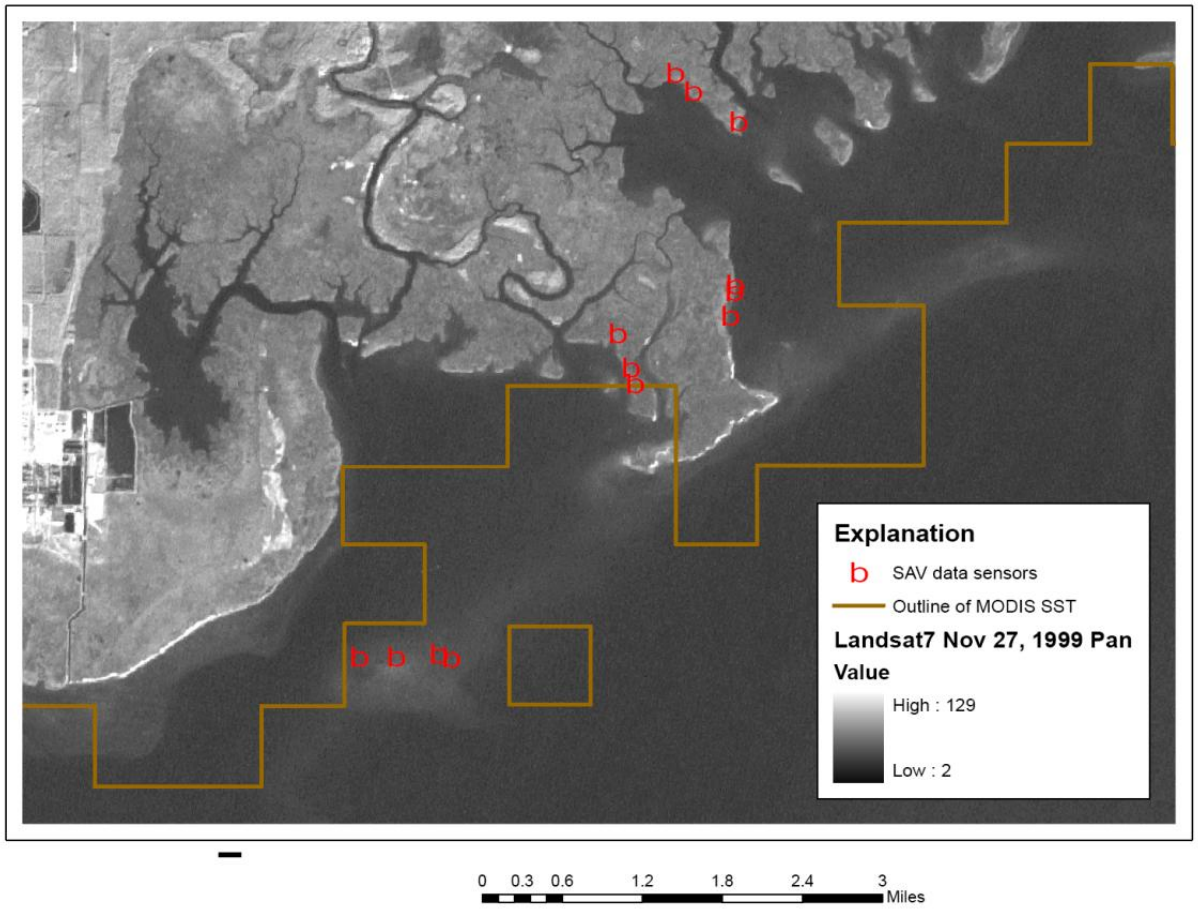
SeaDAS



The SeaWiFS Data Analysis System (SeaDAS) is a comprehensive image analysis package for the processing, display, analysis, and quality control of ocean color data.

Land mask issues

Default MODIS 1-km land mask obscures much useful data at or near the Grand Bay seagrass beds



Near-shore processing

- Environmental factors that play a major role in controlling seagrasses, that can be acquired with remote sensing data, include:
  - chlorophyll *a* concentration (as an indicator of nutrients presence)
  - diffuse light attenuation coefficient for PAR (photosynthetically active radiation)
  - sea surface temperature (SST)
- Time series of these parameters created from the Level 1B MODIS data products obtained from the NASA distribution server
- The Level 1B calibrated radiance products are processed using the SeaDAS software to apply atmospheric correction (based on SWIR and NIR bands) and to retrieve inherent optical properties (IOPs) of coastal ocean areas
- The following IOPs are calculated using the Quasi-Analytical Algorithm:
  - phytoplankton absorption coefficient at 443 nm, $a_{ph}(443)$
  - total absorption coefficient and total backscattering coefficient at 488 nm, $a(488)$ and $b_b(488)$

Data Retrieval

- Chlorophyll *a* concentration
  - A. Bricaud, M. Babin, A. Morel, and H. Claustre, “Variability in the chlorophyll-specific absorption coefficients of natural phytoplankton: Analysis and parameterization,” *J. Geophys. Res.*, vol. 100, pp. 13321-13332, July 1995

$$Chl = \left[\frac{a_{\mathrm{ph}}(443)}{A(443)}\right]^{\frac{1}{1-B(443)}}$$

- Diffuse light attenuation coefficient for PAR
  - Z.-P. Lee, A. Weidemann, J. Kindle, R.A. Arnone, K.L. Carder, and C. Davis, “Euphotic zone depth: Its derivation and implication to ocean-color remote sensing,” *J. Geophys. Res. (Oceans)*, vol. 112, p. 3009, March 2007

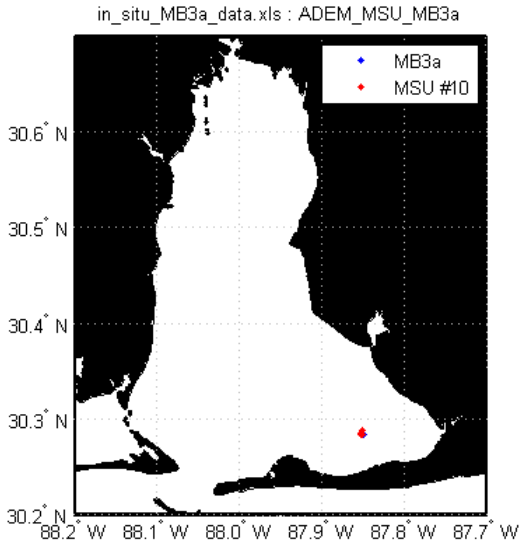
$$K_{\mathrm{d}}(\mathrm{PAR}, z) = K_1 + \frac{K_2}{\sqrt{1+z}}$$

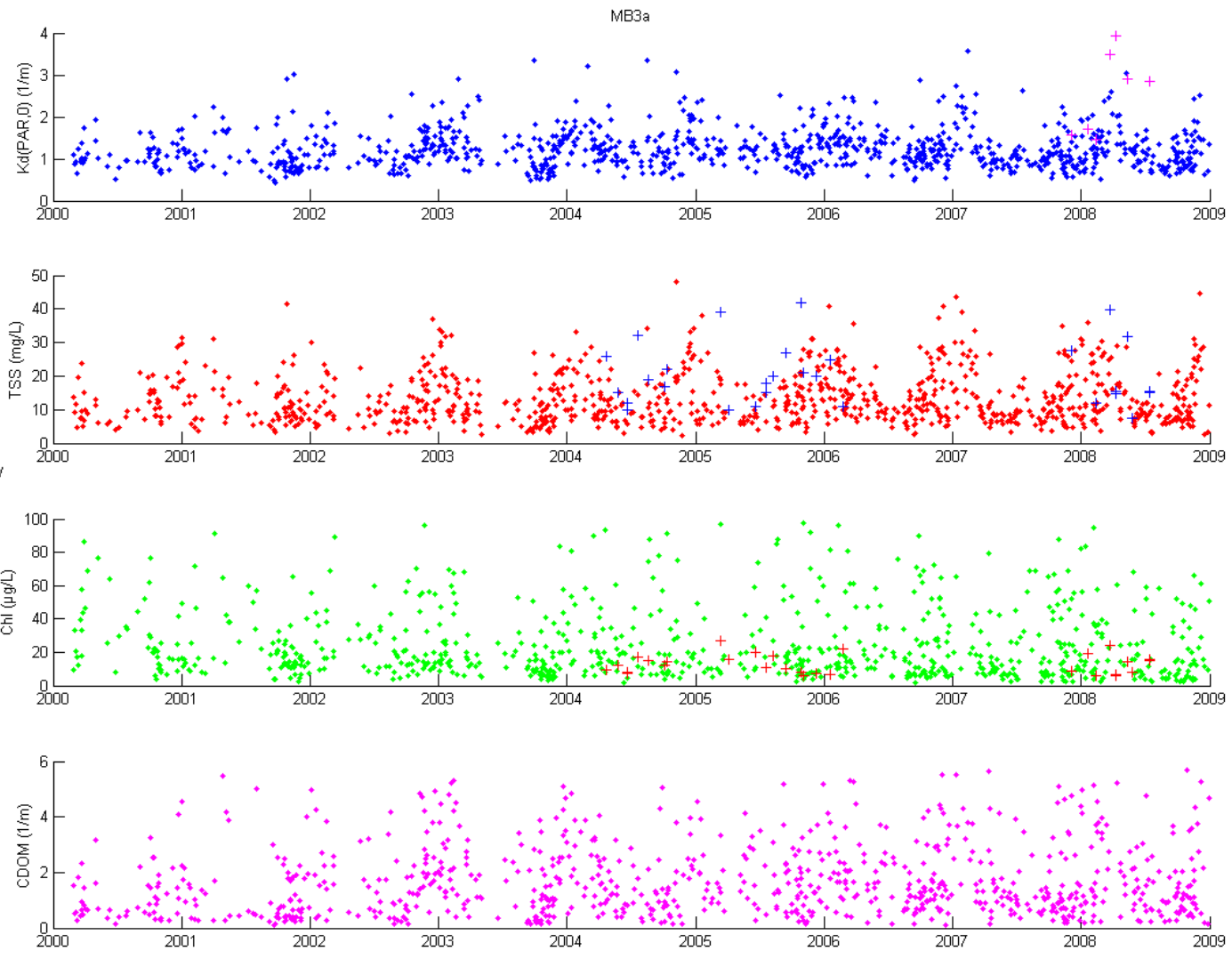
$$K_{\mathrm{d}}(\mathrm{PAR}, 0) = K_1 + K_2$$

K_1 and K_2 calculated from $a(488)$ and $b_b(488)$

- Sea Surface Temperature
  - directly from SeaDAS

Point Measurements





- Above: Location of the ADEM monitoring station MB3a in Bon Secour Bay
- Right:

(·) Time series of water clarity parameters retrieved from MODIS data for the MB3a station location

(+) MB3a surface monitoring data collected by ADEM in 2004-2006 and MSU in 2007-2008

Blonski, S.; Holekamp, K.; Spiering, B.A., "NASA Satellite Monitoring of Water Clarity in Mobile Bay for Nutrient Criteria Development," Proceedings of OCEANS 2009 MTS/IEEE Conference, Biloxi, MS, October 26-29, 2009.

Discussion

- Time series derived information for coastal waters will be used to provide input data for the Fong and Harwell model
- The current MODIS land mask limits where the model can be applied; this project will
  - Apply MODIS data with resolution higher than the standard products (250-m vs. 1-km)
  - Seek to refine the land mask,
  - Explore nearby areas to use as proxies for time series directly over the beds
- Novel processing approaches will be leveraged from other NASA projects and customized as inputs for seagrass productivity modeling

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